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09/919,511	07/31/2001	Leslie L. Deck	09712-116001	2774

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FISH & RICHARDSON PC
225 FRANKLIN ST
BOSTON, MA 02110

EXAMINER	
LEE, SHUN K	

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Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

Office Action Summary	Application No. 09/919,511	Applicant(s) DECK, LESLIE L.
	Examiner Shun Lee	Art Unit 2878

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *25 November 2002*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-54* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-16,27,28 and 30-54* is/are rejected.

7)☒ Claim(s) *17-26 and 29* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *31 July 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-16, 27, 28, and 30-54 are rejected under 35 U.S.C. 103(a) as being unpatentable over Groot (US 6,359,692) in view of Suematsu *et al.* (Applied Optics 30:4046-4055, 1991).

In regard to claims **39**, **45**, **47**, and **48**, Groot discloses (Fig. 1) an interferometry system for characterizing a test object, the system comprising:

(a) a frequency-tunable light source (22, 24);

(b) an interferometer comprising at least one reference surface (36), wherein during operation the interferometer directs different portions of an optical wave front derived from the light source (22, 24) to multiple surfaces of the test object (40) and the at least one reference surface (36) and recombines the different portions to form an optical interference image, the multiple surfaces of the test object (40) and the at least one reference surface (36) defining a set of cavity surfaces;

(c) a multi-element photo-detector (32, 33) positioned to record an interference signal at different locations of the optical interference image in response to frequency

tuning of the light source (22, 24), wherein the interference signal includes a contribution from each pair of different surfaces in the set of cavity surfaces; and

(d) an electronic controller (60) coupled to the light source (22, 24) and the photo-detector (32, 33).

The interferometry system of Groot lacks that during operation the controller, for each location, calculates a frequency transform of the interference signal at a frequency corresponding to each of selected pairs of the different surfaces in the set of cavity surfaces and extracts the phase of the frequency transform at each of the frequencies corresponding to the selected pairs of surfaces. (OFDR) optical frequency domain reflectrometry is known in the art. Suematsu *et al.* teach (left column first paragraph on pg. 4047) that OFDR is used to read distance of multiple reflectors from the location of spectrum peaks appearing in the frequency spectrum of an interferometric signal and to transform the interference signal into the frequency domain (using, for example, a Fourier transform such as a Fast Fourier transform and a window function such as a Hanning window; left column first paragraph on pg. 4051) in order to determine the phase accurately by excluding unwanted influences (the lines between Eqs. 10 and 11 in the left column on pg. 4048) and identifying (lines 1-3 on right column on pg. 4048) a frequency corresponding to each of one or more selected pairs of surfaces from the frequency domain representation of the interference signal. Groot teaches (column 6, lines 16-18) that distance h(x,y) is proportional to a phase θ(x,y) which can be determined by comparing imaginary and real part of the frequency domain representation of the interference signal at a selected frequency (Eqs. 9 and 10).

Therefore it would have been obvious to one having ordinary skill in the art to provide OFDR analysis of the interferometry data in the interferometry system of Groot, in order to determine a phase and optical path distance for each of the selected pairs of surfaces.

In regard to claims **1**, **3**, **5-7**, and **41-44**, the method steps are implicit for the modified apparatus of Groot since the structure is the same as the applicant's apparatus of claim 39.

In regard to claim **40**, Groot is applied as in claim 39 above. The interferometry system of Groot lacks that during operation the controller: transforms the interference signal into the frequency domain for at least one of the locations to produce a transformed signal having series of frequency peaks corresponding the pairs of different surfaces in the set of cavity surfaces; identifies a frequency corresponding to each of one or more selected pairs of surfaces from the series of frequency peaks; and determines an absolute optical thickness for each of the selected pairs of surfaces based on the corresponding identified frequency and the frequency tuning rate. (OFDR) optical frequency domain reflectrometry is known in the art. Suematsu *et al.* teach (left column first paragraph on pg. 4047) that OFDR is used to read distance of multiple reflectors from the location of spectrum peaks appearing in the frequency spectrum of an interferometric signal by transforming (see Figs. 1 and 3) the interference signal into the frequency domain for at least one of the locations to produce a transformed signal having series of frequency peaks corresponding the pairs of different surfaces in the set of cavity surfaces and identifying (lines 1-3 on right column on pg. 4048) a frequency

corresponding to each of one or more selected pairs of surfaces from the series of frequency peaks so as to determine an absolute optical thickness (L in Eq. 21) for each of the selected pairs of surfaces based on the corresponding identified frequency and the frequency tuning rate (see Eqs. 2, 6, 16-18 which defines a reference phase relative to frequency tuning rate). Therefore it would have been obvious to one having ordinary skill in the art to provide an OFDR analysis of the interferometry data in the interferometry system of Groot, in order to determine an absolute optical thickness for each of the selected pairs of surfaces.

In regard to claims **33**, **34**, and **38**, the method steps are implicit for the modified apparatus of Groot since the structure is the same as the applicant's apparatus of claim 40.

In regard to claims **2** and **4** which are dependent on claim 1, the modified method of Groot comprises identifying (see lines 1-3 on right column on pg. 4048 of Suematsu *et al.*) a frequency corresponding to each of one or more selected pairs of surfaces from the frequency domain representation of the interference signal. It should be noted that cavity surfaces inherently have relative positions (see M1, M2, M3, ... ,Mn in Fig. 2 of Suematsu *et al.*) that define nominal optical path length differences L_{mn} and nominal frequencies f_{mn} which are calculated from the frequency tuning rate α_o and L_{mn} (see Eq. 24 of Suematsu *et al.*) and that the identification of a frequency corresponding to each of one or more selected pairs of surfaces in a series of frequency peaks inherently requires a comparison of the series of frequency peaks to calculated nominal frequencies.

In regard to claims **8-10** which are dependent on claim 1, the modified method of Groot lacks that the window function (*e.g.*, a Tukey window, or a Hamming window) is selected to reduce a contribution to the frequency transform at the frequency corresponding to one of the selected pairs of surfaces from at least one other pair of different surfaces in the set of cavity surfaces. Suematsu *et al.* teach (section entitled B. Three-Beam Interferometry pg. 4051-4053; Fig. 10) to isolate by filtering a frequency band corresponding to one of the selected pairs of surfaces from at least one other pair of different surfaces in the set of cavity surfaces. Therefore it would have been obvious to one having ordinary skill in the art to select the window function (*e.g.*, a Tukey window such as a Hamming or Hanning window) in the modified method of Groot, in order to isolate a frequency band corresponding to one of the selected pairs of surfaces from at least one other pair of different surfaces in the set of cavity surfaces.

In regard to claim **11** which is dependent on claim 1, Groot also discloses (column 1, lines 10-13; column 6, lines 16-18) determining the surface profile of one of the test object surfaces based on at least some of the extracted phases.

In regard to claim **12** (which is dependent on claim 1) and claim **46** (which is dependent on claim 45), Groot also discloses (column 1, lines 10-13; column 6, lines 16-18) determining a relative optical thickness profile between two of the test object surfaces based on at least some of the extracted phases.

In regard to claims **13** and **14** which are dependent on claim 1, Groot also discloses (column 1, lines 10-13; column 6, lines 16-18) determining the surface profile of multiple ones of the test object surfaces based on at least some of the extracted

phases. It should be noted that cavity surfaces inherently have relative positions (see M1, M2, M3, ... ,Mn in Fig. 2 of Suematsu *et al.*) and thus a relative orientation is inherent between two of the profiled test object surfaces. Therefore determining the surface profile of multiple ones of the test object surfaces inherently determines relative orientation.

In regard to claim **15** which is dependent on claim 1, Groot also discloses (Fig. 1) that the at least one reference surface (36) comprises one reference surface (36).

In regard to claim **16** which is dependent on claim 15, Groot also discloses (Fig. 1) that the test object (40) has a partially transparent front surface (44) and a back surface (46), the front surface (44) positioned nearer to the reference surface (36) than the back surface (46), and wherein the front, back, and reference surfaces define a three-surface cavity.

In regard to claim **27** which is dependent on claim 1, Groot also discloses (Fig. 1) positioning the test object (40) relative to the at least one reference surface (36) to cause the optical path length difference for each of the pairs of different surfaces in the set of cavity surfaces to differ.

In regard to claim **28** which is dependent on claim 27, Groot also discloses (column 8, lines 8-18) positioning the test object relative to the at least one reference surface to cause contributions to the interference signals from second order reflections in the set of cavity surfaces to occur at frequencies that differ from the frequencies corresponding to the selected pairs of surfaces.

In regard to claims **30-32** (which are dependent on claim 1), claims **35-37** (which are dependent on claim 33), claims **49-51** (which are dependent on claim 41), claims **52-54** (which are dependent on claim 45), the modified method and system of Groot lacks monitoring the frequency tuning with a wavelength monitor comprising an interferometer and calculating the frequency transform based on the monitored frequency tuning. Suematsu *et al.* teach (section entitled A. Combination of the FFT with the Reference Technique pg. 4050-4051; Fig. 4) to monitor the frequency tuning with a wavelength monitor comprising an interferometer (*i.e.*, reference interferometer in Fig. 4) and calculating the frequency transform based on the monitored frequency tuning in order to remove the influence of unwanted variations such as nonlinear and time varying current-wavelength characteristics of a frequency-tunable light source (*i.e.*, laser diode). Therefore it would have been obvious to one having ordinary skill in the art to provide a reference interferometer in the modified method and system of Groot, in order to remove the influence of unwanted variations such as nonlinear and time varying current-wavelength characteristics of a frequency-tunable light source.

Allowable Subject Matter

3. Claims 17-26 and 29 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

4. The following is a statement of reasons for the indication of allowable subject matter: the instant application is deemed to be directed to an nonobvious improvement over the invention patented in US Patent 6,359,692. The improvements comprise in

combination with other recited elements, that the test object is positioned between two reference surfaces as recited in claims 17-26 and that the test object is positioned relative to the at least one reference surface such that the optical path lengths of successive, adjacent pairs of the cavity surfaces are substantially proportional to one another by a unique power of 3 as recited in claim 29.

Response to Arguments

5. Applicant's arguments filed 25 November 2002 have been fully considered but they are not persuasive.

Applicant argues (first two paragraphs on pg. 6 of remarks filed 25 November 2002) that there can be no motivation to combine the two references because the two references are contradictory since Groot makes multiple distance measurements to a single surface, whereas Suematsu *et al.* makes a single distance measurement to each of a multiple of surfaces. Examiner respectfully disagrees. First, it is noted that applicant states (last sentence in the fourth paragraph on pg. 5 of remarks filed 25 November 2002) that "the rejections are all based on performing OFDR analysis as described in Suematsu on the interferometry data of Groot". Groot states (column 1, lines 31-41 and lines 57-60) that "The optical interference patterns define a series of intensity values for each spatial location of the pattern, wherein each series of intensity values has a sinusoidal dependence on the phase-shifts with a phase-offset equal to the phase difference between the combined measurement and reference wavefronts for that spatial location. Using numerical techniques known in the art, the phase-offset for each spatial location is extracted from the sinusoidal dependence of the intensity values to provide a profile of the measurement surface relative the reference surface" and that " ... the net

optical interference image is a superposition of multiple interference patterns produced by pairs of wavefronts reflected from the multiple surfaces of the measurement object and the reference surface". The key phrase is "for each spatial location". Thus it is clear that an identical analysis is performed at each spatial location so as to determine at each spatial location the optical path length between two selected surfaces from a multiple interference pattern produced with multiple surfaces. Suematsu *et al.* teach (Fig. 2 and abstract) an analysis that determines the optical path length between two selected surfaces from a multiple interference pattern produced with multiple surfaces. There is no teaching within Suematsu *et al.* that the method cannot be applied at different spatial locations. Thus, there is no teaching within either Groot or Suematsu *et al.* which teaches away from applying the analysis of Suematsu *et al.* at each spatial location of the interferometry data of Groot.

Applicant argues (third paragraph on pg. 6 to first paragraph on pg. 8 of remarks filed 25 November 2002) that Groot is directed to determining a time-independent phase profile whereas the OFDR of Suematsu *et al.* ignores the time-independent phase. First, it should be noted that Groot states (column 1, lines 37-41) "Using numerical techniques known in the art, the phase-offset for each spatial location is extracted from the sinusoidal dependence of the intensity values to provide a profile of the measurement surface relative the reference surface", "The method includes: ... extracting phases of a selected one of the interference patterns from the recorded images by using a phase-shifting algorithm that is more sensitive (e.g., at least ten times more sensitive) to a wavelength-dependent variation in the recorded images caused by the selected interference pattern than to wavelength-dependent variations in the recorded images caused by the other interference patterns", and "the invention features a method for interferometrically profiling a

measurement object having multiple reflective surfaces". Thus, Groot discloses a method of obtaining phases in order to interferometrically profile a measurement object. It is important to recognize that the step of determining a time-independent phase profile is only an intermediate method step in the analysis of the interferometry data. Further, applicant has stated (last sentence in the fourth paragraph on pg. 5 of remarks filed 25 November 2002) that "the rejections are all based on performing OFDR analysis as described in Suematsu on the interferometry data of Groot". Thus arguments directed to differences in the analysis of Groot in comparison to the analysis of Suematsu *et al.* is immaterial since the rejections are all based on performing the analysis of Suematsu *et al.* on the interferometry data (and not the analysis) of Groot.

Applicant also argues (third paragraph on pg. 7 of remarks filed 25 November 2002) that the surface height resolution is inherently on the order of a wavelength and cites the equation at column 6, line 32. To establish inherency, the extrinsic evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill (see MPEP 2112). It is noted that the equation at column 6, line 32 simply denotes a relationship between the phase profile and the surface profile assuming a perfectly flat reference surface. Applicant has failed to explain how a surface height resolution on the order of a wavelength necessarily follows from the cited equation.

Applicant further argues (fourth paragraph on pg. 7 of remarks filed 25 November 2002) that the analysis of Suematsu *et al.* is insufficient to provide the

surface height profile desired by Groot and cites left column on pg. 4047. First as discussed above, applicant has failed to explain how a surface height resolution on the order of a wavelength <u>necessarily</u> follows from the cited equation of Groot. Thus, applicant has fail to establish what surface height profile is desired by Groot. Moreover, it is noted that the citation from the left column on pg. 4047 only states that the range resolution is limited by the spread of the spectrum peaks. Applicant has failed to explain how a surface height resolution not on the order of a wavelength <u>necessarily</u> follows from the statement that the range resolution is limited by the spread of the spectrum peaks.

Applicant argues (second paragraph on pg. 8 of remarks filed 25 November 2002) that Suematsu *et al.* completely disregards phase. Examiner respectfully disagrees. Suematsu *et al.* state (between equation 10 and 11 on the left column on pg. 4048) that "The first problem is how to determine the phase φ(t) accurately, excluding the influence from other unwanted variations a(t) and b(t)" and (below Eq. 15 on the right column on pg. 4048) that "Since the imaginary part of Eq. (15) calculated by computer gives the principle value of the phase with modulo 2π, the phase φ(t) is wrapped into the range [-π, π], so that its distribution has discontinuities with 2π phase jumps. This wrapped phase is corrected by using a phase unwrapping algorithm.[11] Note that by this technique we can determine the phase φ(t) with the resolution exceeding 2π". Thus it is clear that Suematsu *et al.* disclose how to extract the phase with resolution exceeding 2π.

Applicant argues (third paragraph on pg. 8 of remarks filed 25 November 2002) that Suematsu *et al.* do not disclose subsequent transformation of the interference signal with the identified spectrum peak. Examiner respectfully disagrees. In Eqs. 14

and 15, Suematsu *et al.* disclose a subsequent transformation of the interference signal with the identified spectrum peak.

Conclusion

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shun Lee whose telephone number is (703) 308-4860. The examiner can normally be reached on Tuesday-Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Porta can be reached on (703) 308-4852. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9318 for regular communications and (703) 872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

SL
January 28, 2003

DAVID PORTA
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800